

Subject: INFORMATION: Simplified Procedure for Addressing the Head Injury Criteria of § 25.562 Date: FEB 16 1996

From: Manager, Transport Airplane Directorate, Aircraft Certification Service, ANM-100 Reply to Policy Ltr. Attn. of: TAD-96-002

To: SEE DISTRIBUTION

With the adoption of Amendment 25-64 to add § 25.562 of the Federal Aviation Regulations, quantified human tolerance parameters were introduced into the regulations for the first time. One of these human tolerance parameters is the head injury criterion (HIC). The HIC has proven to be one of, if not the most, onerous aspect of the regulation.

The regulations require that the potential for head injury be assessed, if the head can contact airplane interior structure when exposed to the test conditions specified in § 25.562. If head contact occurs, the HIC must be calculated, and must be less than 1000 units. In the case of repetitive rows of seats, determining the critical area for head injury potential on a seat back can be difficult, and can often result in several tests, just to determine a critical case. This procedure is very expensive, and in most cases unnecessary. However, many applicants lack the data to make an analytical assessment to define a minimum set of tests, and are therefore forced to conduct many tests. The procedure defined in this memorandum will help serve to minimize testing.

One of the aspects of compliance that has been somewhat contentious is the consideration of a "range" of occupant heights for HIC. The dynamic test requirements specify the type of test dummy to be used. This dummy represents the approximate stature of a 50th percentile male. This does not mean that only the 50th percentile male is of concern from a head injury standpoint. In fact, § 25.785(b) requires that a "person" be protected from serious injury under the condition specified in § 25.562. The dynamic test provides the means for making the assessment, but does not change the fundamental requirement to protect each occupant. Historically, we have used a range of occupant heights from the 5th percentile female to the 95th percentile male as a reasonable envelope for consideration. Advisory Circular 25.562 - 1 alludes to the need to consider other occupants, but does not specify or suggest a means for doing so. This lack of methodology has resulted in poor standardization in application of the requirement.

In an effort to reduce the regulatory burden, and simplify/clarify the procedure for demonstrating compliance, we have developed the attached procedure. This procedure should allow demonstration of compliance for HIC with two tests in the majority of cases. The procedure takes into account seat pitch, the relative position of the seat and the row behind it as well as range of occupant sizes. The intent of this procedure is to provide default conditions that can be used in lieu of conducting several tests, or performing lengthy analytical studies. It is recognized that this procedure will not account for every eventuality. The purpose, however, is to provide for reasonable test conditions that meet the intent of the requirements, without causing excessive testing to be performed. This procedure was distributed at the Public Meeting on Dynamic Testing of Seats, in Seattle in October of 1995. Comments received have been considered in the final issuance.

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Attachment

Seat-to-Seat Installation Tests for Compliance with the HIC in Transport Airplanes

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- Attachment to Policy Ltr. TAD-96-002

Seat-to-Seat Installation Tests for Compliance with the HIC in Transport Airplanes

The following is a set of criteria for use in evaluating HIC with "default" parameters. These criteria can be used to standardize the approach to seat-to-seat HIC, and should enable seat-to-seat HIC for the majority of seats to be addressed in only two tests. The general guidelines are based on a typical passenger seat, although the philosophy could be applied to any seat for which it was valid to do so.

Head Strike Envelope:

All dynamic tests and HIC evaluations are to be conducted with a 50th percentile male anthropomorphic test dummy as defined in 25.562. The head strike envelope includes the three dimensional space through which the ATD's head may traverse when tested in accordance with the dynamic conditions defined in 25.562. This three dimensional space includes the ATD's head path which occurs during the vertical test as well as the horizontal-yaw test conditions defined in 25.562 (although the horizontal condition typically produces the critical head path). Since the head of the ATD is a three dimensional object, the head strike envelope encompasses the path of all points defined by the surface of the ATD's head. This includes the back of the head. The head strike envelope for the horizontal-yaw test condition (Test 2) includes the path through which the ATD's head may traverse when tested with a yaw angle of ϕ , $-10 < \phi < +10$ degrees.

Structures within the Head Strike Envelope

If the head strike envelope results in head contact with a structure located on or in the vicinity of the seat installation in an aircraft, the HIC requirement in 25.562 must be demonstrated by test(s). There are some seat-to-seat installation practices which are common to contemporary aircraft, and general guidelines on

certification test procedures can be defined. The following examples describe how the various factors affecting the seat-to-seat HIC result can be addressed in the test(s) protocol.

Seat-to-seat HIC, Double Row Horizontal-Yaw Tests.

Head Strike Zones. Due to the dynamic deflection of the forward row seat back during the impact test, it is usually difficult to accurately predict exactly where the aft row seated ATD's head will strike the seat back. The typical seat back has three areas that are considered head strike zones within the +/- 10 degree yaw range of impact orientation. These are illustrated in Figure 1. Note the recline mechanism is on the left side of the seat back in this illustration. The recline mechanism can affect the stiffness of the seat back on the side it is located (Zone A.) Thus, head impact must be evaluated on both the left and right (Zone B) sides of the seat back. The third area of potential head impact is the center of the seat back (Zone C), which may include areas on the seat back containing a tray table, telephone handsets, or video displays.

Since it is common for the recline adjuster mechanism to be positioned on the left side of some seat backs and the right side of others of the same assembly, the seat-to-seat HIC test for Zones A and B can usually be accomplished in one double row test using two instrumented ATD's in the aft row, with the yaw angle set to effect a head strike in Zone A by one ATD and Zone B by the other. Alternatively, it may be possible to relocate one adjuster mechanism for test purposes. In addition, properly documented developmental test data, that indicate that one condition or the other is more critical, could be used to justify head impact on only one side of the seat.

Seat Pitch.

The range of intended seat pitch for a particular model of seat should be defined in the certification test plan. The HIC assessment test(s) should include, as a minimum, head impact responses for the three head strike zones described above. As a general rule, head impact in Zones A and B is likely to be more severe as the seat pitch increases. This is because the head will strike the seat back at a lower point and will be more likely to contact the arm rest structure. Thus, the maximum intended seat pitch should be evaluated in the critical yaw orientation (within the +/- 10 degree envelope) with head impacts directed at Zones A and B.

Another general rule can be applied to head strike Zone C. The severity of head impact in the middle of the seat back can be affected by the tray table and its latch mechanism. Also, convenience items such as telephone handsets or video displays in the vicinity of the tray table may be contacted by the ATD's head. To assess the severity of head impact in Zone C, an impact test should be conducted at the minimum intended seat pitch in a 0° yaw (no yaw) impact orientation.

Thus, the seat pitch range for a particular model of passenger seat can be certified in a minimum of two tests. The maximum pitch is tested in the yaw orientation with head impacts directed at Zones A and B. The minimum pitch is tested in 0° yaw with head impact in Zone C. Note that this is based on a typical passenger seat, that has an essentially homogeneous contact area across the seat back, in zone C. Designs that differ from this might require an additional test(s), if the contact surfaces are not consistent.

Occupant Height.

Although the seat-to-seat HIC tests do not require evaluating head impact with a range of different size ATD's, the strike zone near the center of the seat back (Zone C) may contain significantly different structures within the close proximity of the head contact area for a 50th percentile ATD. For example, at the minimum seat pitch, a 50th percentile ATD may barely miss a telephone handset installed above the tray table. Under the same impact condition, a taller occupant's head may contact the handset. Likewise, a

50th percentile ATD's head may strike the seat back above the tray table, whereas a shorter occupant's head may strike the top edge of the tray, which may be worse.

In order to provide a consistent level of head impact protection in Zone C for a range of occupant height, it is necessary to examine an area on the seat back near the initial contact point of the 50th percentile ATD's head on the seat back. As a minimum, a rectangular area on the seat back centered at the 50th ATD's initial head contact point must be evaluated. As shown in Figure 2, the area to be evaluated is a 6 by 12 inch rectangle centered in the initial head contact point of the 50th percentile ATD.

If the head contact evaluation rectangle in Zone C includes structures which differ significantly from the contact point of the 50th percentile ATD, an additional test may be necessary. Conversely, if there are data available to predict the contact point of the 50th percentile ATD, these may be used to select the critical test condition, as the initial test in lieu of the zero degree test discussed above. The relative position of the seats in a double row setup must be adjusted to produce head contact with a 50th percentile ATD on the area of concern. Vertical adjustment of the seats' relative position will ensure that a comparable head impact velocity as that measured from the normal position Zone C test is achieved, although other methods that achieve the same objective are acceptable. As a general rule, additional tests are only required if the head contact evaluation rectangle contains rigid items (such as telephone handsets, video screens, and oxygen mask container units.) Areas which are less rigid than the initial contact point within the evaluation rectangle do not require additional tests.

Airplane Taper Section.

HIC evaluations in the taper sections of the airplane may be conducted with the seat(s) in the normal position without simulating the floor track yaw angle due to taper. The lateral offset between rows of seats in a taper section may be neglected (e.g. the double row HIC tests may be conducted with no lateral offset) if the lateral offset of the cabin installation is less than 6.0 inches. Note, structural tests of seats installed in the taper section must be conducted with the additional yaw angle due to taper.

Staggered Seating.

Seats that are staggered (resulting in more than 6" offset) due to a change in the number seat-places for example, should be addressed considering the actual installation. This may prove to be the critical evaluation for the airplane installation, if contact with armrests or other hard structure occurs. Such an installation may supersede the "zone A & B" evaluations discussed earlier. Consideration of such installations should still be possible-within the framework of a two-test program, provided that the basic designs are the same.

Forward Row Seat Setup.

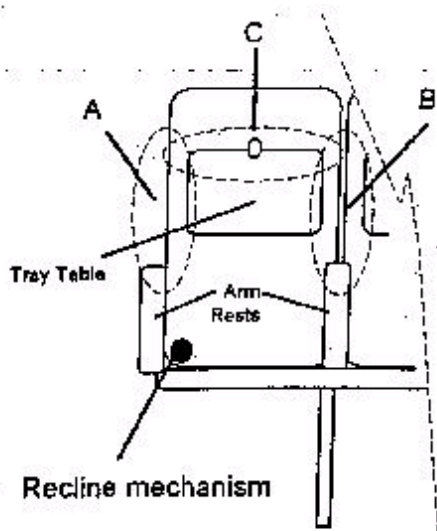
It is acceptable to conduct the double row seat-to-seat HIC test(s) with no ATD's in the forward row seat. Floor deformation should not be induced on either the forward or aft row seats for evaluation of HIC.

Other Factors:

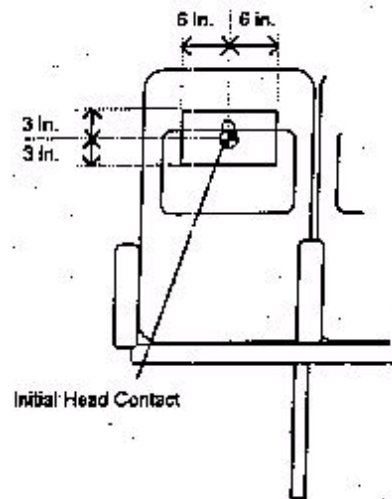
Head Floor Strikes. HIC need not be determined for ATD head strikes with the simulated floor of the aircraft should it occur.

Occupant to Occupant Strikes. Occupant (ATD) to occupant (i.e., opposite facing seats) strikes should be prohibited. The biofidelity of the ATD and appropriate injury criteria related to occupant to occupant strikes is unknown and beyond the scope of the seat dynamic performance standards evaluations.

Sharp Object Strikes. Head strikes with sharp objects are not evaluated with the HIC but they are prohibited per the requirements of FAR 25.785.



(View from back of seat)
Head Strike Zones
Figure 1.



(View from back of seat)
Zone C Head Contact Evaluation Area
Figure 2